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Artificial wind-break studies in Kent

by J R Starr.

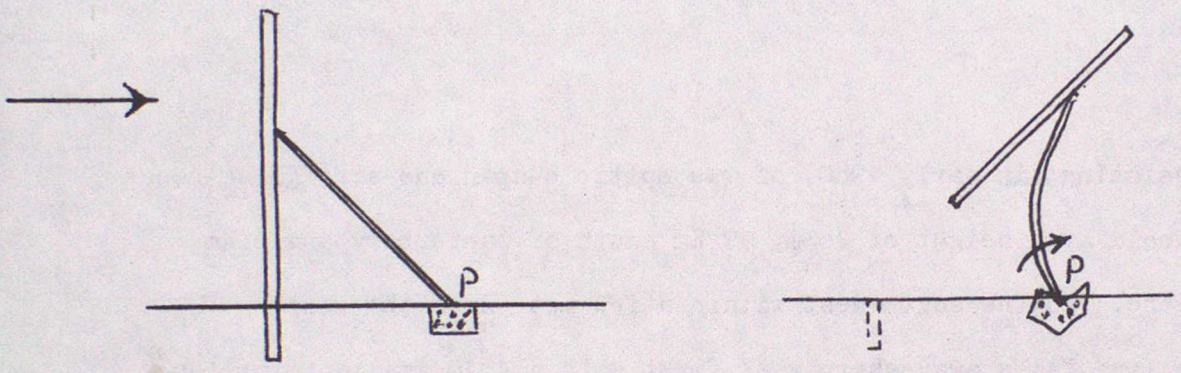
I Hempton Farm, Lyminge : 12 foot (3.7m) Paraweb shelter surrounding a glasshouse area.

Introduction

The enterprise, consisting (in early 1980) of two multiple-span one-acre glass-house blocks, is on the Weald at a height of 183m, 17 Km south of Canterbury and 6 Km to the north of Hythe. To the south-west, within a few met s of the western boundary hedge, the land falls away sharply at first with a 1:10 gradient for the first $\frac{1}{2}$ Km (See OS sketch in fig 1).

In the autumn of 1979 the owner Mr Ironside, sought ADAS advice on siting and types of wind-breaks in the hope of reducing heating bills and minimising the possibility of wind-damage. With glasshouse ridges to some 15' and gutters at 10' shelter to at least 12' was necessary. Mr Ironside wished for 'instant shelter' rather than wait the five or so years necessary for natural shelter to become effective. A 12' high 'Paraweb' wind-break was erected in late November 1979. Telegraph poles at 10' (3m) intervals were supported (on the glass-house side only) by twin $1\frac{1}{4}$" iron tubing lengths embedded in concrete. No gaps were left; access paths were achieved by staggering or overlapping or wind-breaks. Mr Ironside was advised that the gust speeds likely to be exceeded once in 10 and 50 years at 10m over open, level country at Manston were: $35ms^{-1}$ (70 knots) and $39ms^{-1}$ (78 knots) respectively.

On the night of 9/10th December 1979, the East Kent Coast recorded south-westerly winds gusting to 52Knots(or 26 m/s), exceeded no doubt at Lyminge due to acceleration up the steep escarpment. Although these gusts were not of exceptional strength severe damage occurred to the wind-breaks. The support poles of those down the west side of the glasshouse area were lifted out of the soft ground, pivotting the iron poles about their concrete support, P (bending the poles or lifting the concrete blocks) thus:



and being deposited flat on the ground.

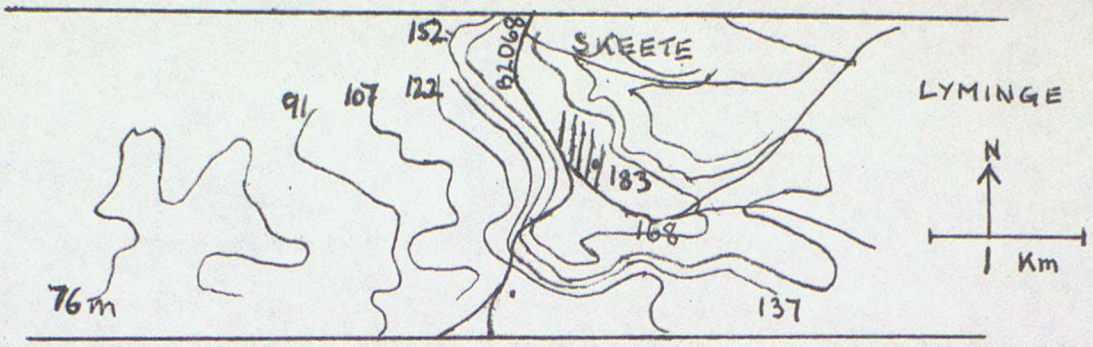
Estimates of wind stress indicated a force of 662 lbs (about 0.3 ton) per pole (Starr 1978).

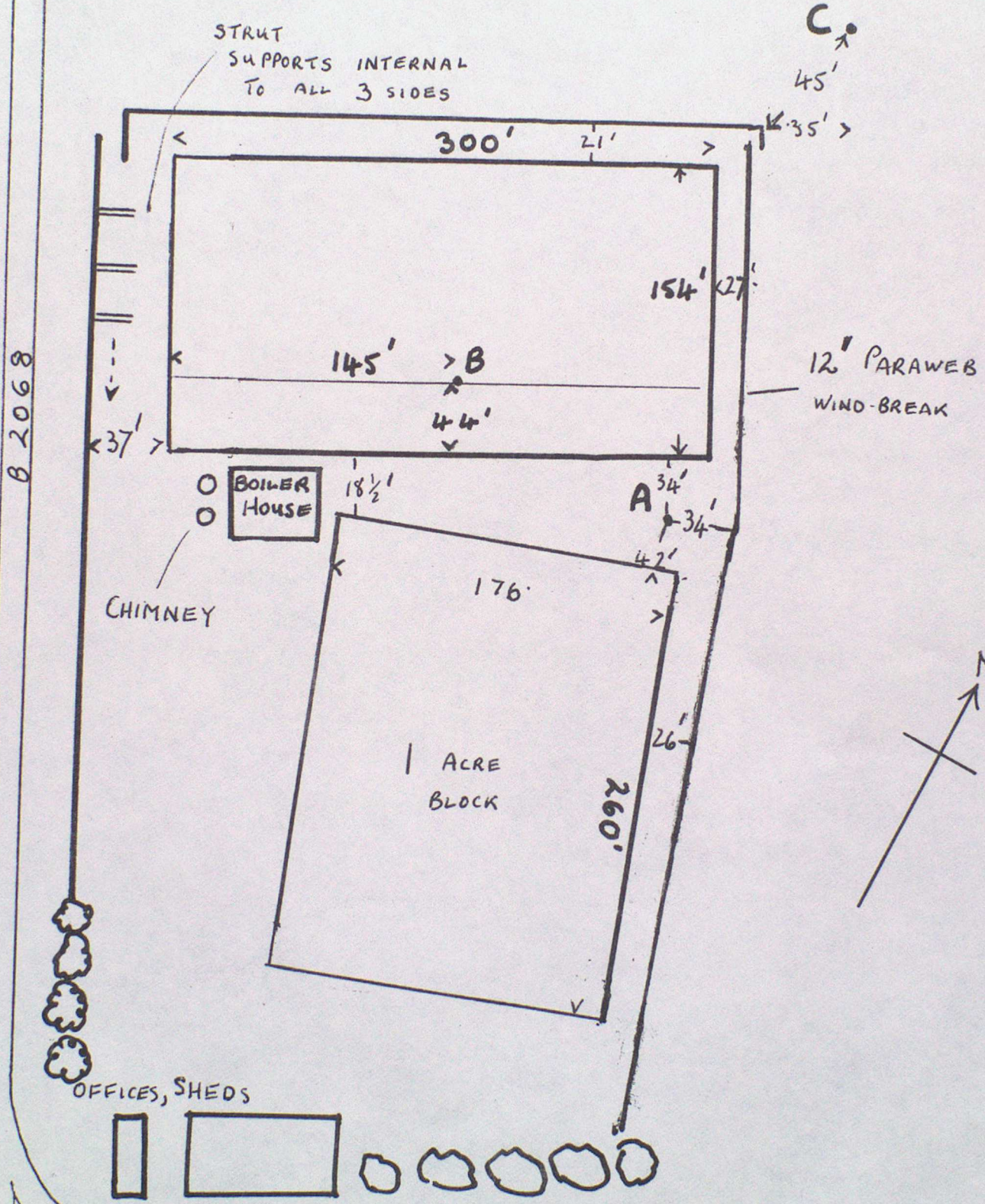
Subsequently the poles have been embedded in concrete and wire guys affixed to support the poles on both sides at right angles to the wind-break length as recommended in MAFF Pub. 2076, 1979: 'Artificial wind-breaks and their supports'.

Run-of-wind measurements

The cup-counter run-of-wind anemometers were erected to be level with the top of the wind-break so as to study the influence of the wind-break on air-flow at glass-house ridge level. Sites were located as sketched, C being about 4'H' outside the sheltered area and B on the roof mid-way between gutter and ridge (and halfway

Fig 1





SKETCH PLAN OF HEMPTON FARM

along a span). A was in an open area between the two 1 acre glass-house blocks some 3H from the wind-break on the north-east side (a region of accelerating air-flow under an easterly wind due to the inclination of one block to the other).

Daily wind runs with 'spot' directions at about 09 GMT were recorded from late January 1980 to mid March 1980 and occasional readings were made until early June 1980.

Results

Wind directions for the data for January to March were identified using on site 'spot' readings and Manston anemograph records and then daily wind-runs were analysed to give for each quadrant (N, S, E, W) the mean ratio of A and B to C (the 'free' wind). Corresponding 'coefficients of variation' were calculated (Tyldesley, 1980) and presented in table 1a.

Total wind runs, irrespective of direction for January to March were compared with those for the April - June period (table 1b).

Table 1a

	QUADRANT CENTRED ON:			
	E	S	W	N
Wind-run at C (miles)	771	1570	956	106
Mean (direction frequency)	257 (3)	131 (12)	191 (5)	106 (1)
Coeff of variation (cfv)	0.48	0.50	0.69	-
Run A/C	0.66	0.88	0.74	0.91
% reduction $\frac{C-A}{C}$	34	12	26	9
cfv of % reduction	0.06	0.28	0.41	-
Run B/C	0.52	0.67	0.68	0.50
% reduction	48	33	32	50
cfv of % reduction	0.34	0.35	0.16	-

If the reduction of wind at A and B was always constant then cfv would be zero.

Table 1b

	A	B	C
Period: 22 January to 19 March 1980 (miles)	7122	5434	8729
ratio to C	0.82	0.62	1
% reduction with respect to C	18	38	-
Period: 15 April to 5 June 1980	6482	5047	8546
ratio to C	0.76	0.59	1
% reduction with respect to C	24	41	-

Summary

With no obstruction upwind but the wind-break (ie under an easterly wind) the ratio of wind at 3H downwind (A) of the wind-break to the 'free' wind (C), also measured at wind-break height, is 0.66 (table 1a). A low coefficient of variation 0.06 reflects the lack of gust-inducing structures upwind.

Wind-flow at A will be influenced by the presence of glasshouse structures for winds from other directions; C may be so influenced under a south-westerly wind.

Under a westerly A (at 27H) is little affected by the upwind wind-breaks; other solid intervene; a relatively high cfv in the % reduction A/C of 0.41 is noted, the ratio A/C averaging 0.74.

Under a northerly wind A/C is 0.91, A being unsheltered by the glasshouse when the wind is north-easterly; (no north-westerly winds were noted in the January to March period).

B is on the roof of the glasshouse; reductionsof 30 to 50% compared with C are noted (table 1a) again with high cfv of % reduction due to structurally induced turbulence. The cfv is least (0.16) under a westerly when perhaps the wind flow is ducted along the gutter to B. Apparently less ducting occurs under an easterly (cfv 0.35).

Table 1b indicates that at ridge height an overall wind reduction of some 40% was achieved mid-way along the multiple span roof over the 6 month period January to June 1980. The corresponding overall reduction in the more 'open' area at A is around 20%; such wind reduction should have an influence on heat loss and corresponding energy saving. Mr Ironside remarked on the 'uniformity' of growth of the season's tomato plants; in previous seasons, retarded growth was clearly apparent towards the west-end of the glasshouses.

In preparation for the 1981 season, the wind-break to the north-west end of the enterprise has been taken down and a further 1 acre glasshouse block constructed; anemometers C and A have been moved to the western side, C continuing its 'free' wind monitoring role and A being in an open area within the glasshouse complex.

II MAFF Brogdale National Fruit Trials: trials on shelter efficiency and resistance to weathering of various wind-break materials.

Introduction

An ADAS Demonstration entitled 'Wind-break Workshop' was held at Brogdale in Spring 1978 when lengths of various artificial wind-break materials, erected appropriately were made available for inspection by manufacturers. The Meteorological Unit at MAFF, Reading aided by Mr Sills (then attached to the Meteorological Unit at Porton) did certain demonstrations of the nature of the

air-flow in the vicinity of various wind-breaks on the day of the 'Workshop'.

It was decided then a very important aspect of the value of shelter to a customer was its weathering ability (some materials had no U.V. inhibitor added) and that materials should thus be monitored for sheltering efficiency and durability over several seasons. (See Table 2)

Equipment and data

Run-of-wind data were obtained for a number of materials which were firmly supported in 20 m lengths, height being 2 m. Many lengths of different materials were erected to form continuous shelter for a young orchard and soft fruit. Some stretches were arranged east-west, thus providing shelter from northerly or southerly winds and other stretches were north-south.

Arrays of 14 cup-counter anemometers, exposed at 1 metre height were located amongst the young trees or bushes perpendicular to each length of material (roughly along the mid-point line). Two anemometers were to one side, at 5 and 10H, and three to the other at 1, 5 and 10H. Daily readings were made over a 6 month period July 1978 to January 1979.

Using the East Malling anemograph data in conjunction with 'spot' wind directions from Brogdale meteorological site days were selected when over a 24 hour period winds were from a well defined direction appropriate to the shelter orientation.

Days of 'constant' wind direction (during periods when data was taken) were identified as follows:

Southerly	1978	July 21, 22, 23, 24, 27, 28,
		Sept 7, 9, Oct 10
	1979	January 16, 17, 26, Feb 1
Northerly	1978	July 13, Sept 20
Westerly	1978	Sept 8, 13, 14, 26, 27, 29, Oct 6

Each appropriate wind run was expressed as a percentage of the 'free wind' (taken to be that run measured at 5 H upwind).

Since the percentage wind reduction is more pertinent (and often has more meaning to the user) it is this factor that is tabulated (table 3).

Summary of shelter studies

At 1 H: the greatest reduction was apparently 80% behind WB63
the least - 67% behind NICOFENCE

At 5 H: again high reduction of 61% behind WB63
the least being 32% behind LOBRENE

At 10H: highest reduction of 39 and 37% respectively behind NETLON and WB63
the least being behind ROKALENE 1728 and NICOFENCE (22 and 20% respectively)

Note :WB63 measurements would have occurred when no foliage was on the trees or bushes.

Weathering

At the time of writing some of the test materials have been established for some 3 years. Papronet, one of the materials without an UV inhibitor added, was holed and brittle and about to break-up. (This material is still under test at Brogdale and shelter data does not appear in the table).

Table 2

Name of Netting	Material
Nicofence '41'	Black U/V stabilised polythene 55% Porosity 55% Shade
Paraweb 50	50mm (2") wide black strips spaced 50mm (2") apart Vertical bands at 1m (39") intervals Withstands salt water and sunlight
Lobrene KX15	Green knitted mesh of U/V stabilised high density polythene 60% Porosity 55% Shade
Black Mono WB 63	55-60% Porosity 63% Shade
Netlon	Heavy duty black 6mm round mesh
Papronet	High density U/V stabilised (?) polyethylene + polypropylene coloured blue, green, black, orange, brown or natural
Rokolene 1728	Green U/V stabilised 100% high density polythene of knitted construction. Life of 4 years 50% Shade

Table 3

Artificial wind-break study 1978/79

Summary Table

Material	DOWNWIND DISTANCE x H				wind direction	occasions	period
	1	2	5	10			
NICOFENCE	67		44	22	S	6	Jul/Aug 1978
			47		N	1	
ROKALENE 1728	54		40	20	S	6	
			57		N	1	
LOBRENE KX15	52		36	27	S	6	
			29		N	1	
PARAWEB		51	42	?	S	3	Sep/Oct 1978
			30*	12*			
NETLON	52		41	39	W	8	
WB 63	80		61	32	S	4	Jan/Feb 1979

The table shows <u>percentage reduction</u> of wind-flow at down-wind distances of 1 (or 2), 5 and 10 times the wind-break height H (where H = 2 metres)

The 'free-wind' was taken as that measured at 5 H upwind

* Based on data from Ag Mem 890

? :(PARAWEB '10H' reduction was inconclusive due to an equipment fault)

References

Starr J R (1978) Shelter-belt surveys in Kent
Agricultural Memorandum 832.

Tyldesley J B (1980) Shelter in an area congested with glasshouses
Agricultural Memorandum 880

also: MAFF Pub. 2076, 1976 Artificial wind-breaks and their supports.

Acknowledgements

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Please refer any comments and criticisms to the author.

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MAFF, Reading

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